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Clinical

Training the next generation of invasive cardiologists: Feasibility of implementing a trans-radial access program at an academic hospital☆

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ABSTRACT

Background: Slow adoption of trans-radial access (TRA) for left heart catheterization (LHC) in the U.S. may be related to concerns about procedural complexity and a steep learning curve. However, TRA acceptance among novice operators remains poorly characterized.
Methods: We initiated a 1-year TRA learning period among lower-risk outpatients, followed by a "radial-first" policy for all LHC patients beginning year 2. By year 3, all fellows prospectively collected diagnostic LHC data as part of a quality improvement study. TRA procedural characteristics were compared with patients undergoing trans-femoral access for the 3 months prior to the TRA program, and trends over time were evaluated.
Results: Between 7/2009 and 6/2012, we identified 960 patients undergoing LHC via TRA by 23 rotating cardiology fellows supervised by 5 interventional cardiologists. When evaluated against the 160 trans-femoral comparator patients, TRA patients had lower procedural success through the initial access site (88% vs. 99%, $p < 0.001$) and longer fluoroscopy times (9.5 [5.8–15.9] vs. 6.5 [3.1–12.7] min, $p < 0.001$), with similar contrast volumes and fewer catheters used. Despite tackling more complex patients during years 2–3, there were improvements in fluoroscopy times, catheter utilization, contrast volumes, and procedural success rates over time (all $p < 0.001$).
Conclusions: The dedicated adoption of TRA by an academic catheterization laboratory demonstrated improvements in efficiency and resource utilization over a relatively short period of time. Additional exposure to TRA during training may help facilitate acceptance of this approach among the next generation of invasive cardiologists.
Short summary (for annotated table of contents): When initiating a trans-radial access program for cardiac catheterization at an academic training hospital, procedural success rates were lower and fluoroscopy times were higher than traditional trans-femoral access. Nonetheless, other procedural variables were similar between the 2 approaches, and improvements over time were consistent with the learning curves reported among experienced cardiologists in prior studies. Exposure to trans-radial access during training may help facilitate acceptance of this approach among the next generation of invasive cardiologists.

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1. Introduction

Trans-radial access (TRA) for cardiac catheterization is associated with fewer vascular complications, less bleeding, shorter recovery time, and improved patient comfort when compared with trans-femoral access (TFA) [1–5]. Some studies have suggested lower mortality among patients with ST-segment elevation myocardial infarction [4,6,7]. However, adoption in the U.S. has been relatively slow [5], largely due to concerns about technical difficulty, longer procedural times, and lower success rates [8–15]. Furthermore, TRA is not consistently taught in cardiology fellowship programs [2], or sporadic exposure is provided by select physicians or in select patients, with relatively vague training guidelines related to gaining competence from a variety of vascular access locations [16,17]. As a result, the TRA learning curve may be relatively cumbersome after establishing procedural skills from the femoral approach.

Despite these concerns, prior studies have suggested that TRA is feasible in a wide variety of patients when cardiologists dedicated to TRA apply this technique to their patients undergoing left heart

Abbreviations: LHC, left heart catheterization; PCI, percutaneous coronary intervention; TFA, trans-femoral access; TRA, trans-radial access.

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catheterization (LHC) [18,19]. In addition, procedural success rates and efficiency improve significantly with additional TRA experience of both the operator and the catheterization laboratory [2,20]. However, many of these findings have been reported among experienced operators at high-volume centers, or among select lower-risk patients. Few data exist regarding the adoption of TRA among trainees without prior catheterization experience [18].

To assess the feasibility of teaching TRA to the next generation of invasive cardiologists, we evaluated procedural success rates, resource utilization, and the learning curve associated with the initiation of a "radial-first" policy at an academic catheterization laboratory.

2. Methods

2.1. Patient population

In July 2009, our cardiology group at a university hospital adopted a "radial-first" policy for uncomplicated patients undergoing diagnostic LHC at the outpatient catheterization laboratory. Standard exclusion criteria for TRA during this initial 1-year learning phase were inadequate dual radial and ulnar arterial circulation to the hand (tested with a pulse oximeter), end-stage renal disease, or previous coronary bypass surgery. Other decisions regarding access were made at the discretion of the attending cardiologist (poor radial pulse, peripheral arterial disease, etc.).

We then expanded our radial program to include all eligible patients undergoing LHC between July 2010 and June 2011 (year 2). In particular, we included acute coronary syndromes, prior bypass surgery, elderly or frail patients, and other clinical scenarios not considered during year 1. Although femoral access was occasionally required on an individual basis, no systematic exclusion criteria were followed for this second phase of TRA adoption. Data for years 1–2 were collected retrospectively from procedure logs in which fluoroscopy times, contrast volumes, and equipment utilization were systematically recorded according to standard protocol.

Between July 2011 and June 2012 (year 3), all patients continued to be evaluated primarily for TRA, but our cardiology fellows prospectively collected TRA procedural data as part of a quality improvement initiative. To avoid confounding related to procedures without clear distinction between diagnostic LHC and other simultaneous procedures, patients with acute ST-elevation myocardial infarction, staged percutaneous coronary intervention (PCI), or combined right and left heart cardiac catheterization were not included in the prospective TRA database.

As a comparator group, we collected data on all patients who were primarily accessed via the femoral approach during the 3-month period just prior to the adoption of our TRA program (i.e., April 2009 through June 2009). Procedural variables for the TFA patients were collected retrospectively in the same manner as for the TRA patients from years 1–2. Of note, the database created for this study included patients whose procedures were initiated by the cardiology fellows, and only patients treated at the primary university hospital were eligible for analysis. Adequate documentation of access and procedural times, along with other variables required for our analyses, was required for a given study to be included in the database.

2.2. TRA technique

The interventional attending physicians at our hospital had limited TRA experience beforehand, so after attending several TRA lectures and training courses at scientific meetings, the attending physicians intermittently performed these procedures themselves, with the fellow as an assistant only. After several months of gaining experience, by July 2009 (when our TRA program was launched) we had returned to our usual catheterization laboratory protocol, such that the cardiology fellow was the first person attempting arterial access with supervision from the attending physician. Subcutaneous lidocaine was injected, the radial artery was cannulated, and a hydrophilic sheath was advanced over a guidewire. Access method was not standardized, although the majority of our operators employed the front-wall needle access approach. Spasmolytic therapy was administered through the arterial sheath (verapamil and/or nitroglycerin), and systemic antithrombotic therapy was given intravenously. Guidewires were chosen based on operator preference. A large proportion of our diagnostic procedures were performed using catheters designed for cannulation of both the right and left coronary arteries (e.g., Jacky catheter). At the completion of each procedure, hemostasis was achieved using radial compression devices.

2.3. Data definitions

Time to access was defined as lidocaine infiltration to sheath insertion. Access success was considered placement of a sheath in the radial artery; when TRA failed at the initial site but was successful on the contralateral side, TRA was considered successful, although time to access was calculated from initial lidocaine infiltration to placement of the final [contralateral] radial sheath. Procedural success was defined as the ability to complete the entire intended procedure (diagnostic ± ad hoc interventional procedure) via the initial access location. Reasons for TRA procedural failure were classified as radial vasospasm, arterial tortuosity or stenosis, inability to cannulate a coronary artery or graft, or hemodynamic compromise or complex PCI requiring large-bore access via TFA. Interventional procedures were defined as PCI or other reasons for placing an intracoronary wire (intravascular ultrasound or fractional flow reserve).

2.4. Statistical approach

All patients with initial radial access attempts were defined as the TRA group. Procedural characteristics of all TRA patients were compared with the TFA comparator group using chi-square for categorical, t-test for continuous, and nonparametric alternatives for variables without normal distribution. Two prespecified confirmatory analyses were performed, due to potential confounding from extra fluoroscopy time, contrast volume, and catheter utilization among patients with (a) left ventriculography and (b) subsequent ad hoc PCI. As such, all comparisons were repeated among the subgroups of TRA and TFA patients undergoing coronary angiography only (after excluding those undergoing left ventriculography), and then among those patients with LHC only (after excluding patients proceeding to interventional procedures).

For the learning curve analyses, patients were consolidated into 3-month blocks (Jul–Sept. 2010, Oct.–Dec. 2010, etc.) so that characteristics would be evaluated by quarters of treatment over the 3-year study period. Categorical variables were analyzed using the Mantel–Haenszel trend test and continuous variables were evaluated by linear trend tests. Given the increase in patient complexity during years 2–3, we anticipated that fluoroscopy time and contrast volume may increase, along with the frequency and complexity of ad hoc PCI. Since these trends would potentially interact with learning curves, we again performed confirmatory trend analyses among the subsets of TRA patients (a) without left ventriculography and (b) with diagnostic LHC only.

All analyses were performed using SAS (version 9.3, SAS Institute, Cary, NC). The study protocol was reviewed and approved as exempt by the Institutional Review Board of Saint Louis University. All authors have reviewed the data and agree to the manuscript as written.

3. Results

3.1. Patients enrolled

During the overall 3-year TRA adoption period, in which 23 rotating cardiology fellows were supervised by 5 interventional cardiologists, we identified 960 patients undergoing LHC via TRA in whom complete procedural data were available (Fig. 1). Right radial access was initiated in 860 procedures (90% of the TRA group), with progressively increasing

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